## REMARKS

Applicant would like to thank the Examiner for the careful consideration given the present application. The application has been carefully reviewed in light of the Office action, and amended as necessary to more clearly and particularly describe the subject matter which applicant regards as the invention.

The abstract of the disclose is objected to. A new abstract has been submitted on a separate sheet.

The specification is objected to due to grammatical errors. The specification has been amended to correct the grammatical errors. No new matter has been added.

The summary of the invention is objected to. The summary of the invention has been amended. No new matter has been added.

The disclosure is objected to because of informalities. The disclosure has been amended to correct the informality on page 14, line 27. The information on page 32, lines 29-30 has not been changed, as the "open end" is part of a hypothetical as explained on page 31, lines 5-16.

Claims 1-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over either JP 62-103526 or the admitted prior art. For the following reasons, the examiner's rejection is respectfully traversed.

JP 62-103526 and the admitted prior art do not teach or suggest all the elements of the claimed invention as recited in claims 1, 6, 9, and 18. The Office action contends that the numerical limitations of the elements of the acceleration sensor according to the present invention are a mere change in size, shape, or number, which is generally recognized as being within the level of ordinary skill in the art, citing In re Rose, 105 USPQ 237 (CCPA 1955). However, the numerical limitations appearing in the claims are generally as in the field of inventions relating to chemical and metal compositions. The applicant has reached the present invention related to the acceleration sensor after conducting various research and repeated tests. Therefore, the limitations are not the result of routine expedients, or a matter of choice that a person of ordinary skill in the art would have found obvious.

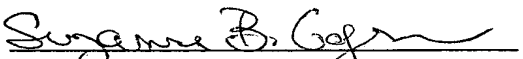
In general, a certain object like an acceleration sensor according to the present invention is apt to be subject to various vibrations. It is found to be difficult to reduce the vibrations to a minimum level and to analyze the vibrations for exploring the causes of the vibrations. This is because such an object is inclined to depend on the sensitive effects caused by its mass, bulkiness, shape, material constituting the elements thereof, and other factors. In order to facilitate and accelerate an analysis process, such an acceleration sensor as defined in claims 1, 6, 9, and 18 is required to be constructed by elements designed to have their optimum measurements. Therefore, the claimed device is patentably distinct from the prior art devices of JP 62-103526 and the admitted prior art because each of the numerical limitations in these claims are of a critical nature, and the claimed relative dimensions perform differently than in the prior art devices. Thus, the present invention as claimed in claims 1, 6, 9, and 18 would not have been obvious, and a rejection under 103(a) is not proper.

In light of the foregoing, it is respectfully submitted that the present application is in a condition for allowance and notice to that effect is hereby requested. If it is determined that the application is not in a condition for allowance, the Examiner is invited to initiate a telephone interview with the undersigned attorney to expedite prosecution of the present application.

If there are any additional fees resulting from this communication, please charge same to our Deposit Account No. 16-0820, our Order No. 33626.

Respectfully submitted,

PEARNE & GORDON LLP

By: 
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Date: February 21, 2003

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IN THE SPECIFICATION:

The paragraph at page 4, line 18, beginning "However, the acceleration sensors of the prior art...", has been amended in the following manner:

> However, the acceleration sensors of the prior art possess their own distinct limitations. Generally, as shown in FIG. 30, the oscillation plate 802 and the piezoelectric element 803 of those acceleration sensors have resonance characteristics in the vicinity of the point of the resonance frequency fo. However, in the case of those conventional acceleration sensors, an acoustic standing wave can be generated in a certain size of the closed space in which the oscillation plate 802 and the piezoelectric element 803 are oscillatably accommodated. As shown in FIG. 31, in the event of generating two peaks of resonance in the vicinity of the point of the resonance frequency fo, a large anti-resonance peak (hereinafter "dip") can be generated because of their phase difference. This large dip can be the cause of spurious noise which deteriorates the characteristic of an acceleration sensor. In addition, in this case of those conventional acceleration sensors, an acoustic resonance can be generated in the closed space, which can be the cause of generating a dip. This dip can be also the cause of spurious noise which deteriorates the characteristic of an acceleration sensor.

The paragraph at page 4, line 31, beginning "As this spurious is generated by acoustical reason...", has been amended in the following manner:

> As this spurious noise is generated by [acoustical reason] sound, the frequency of generating spurious noise varies according to the sonic speed u. For example, the sonic

[multiplies] speed increases 1.18 times when the temperatures change from 20 to 120, which can be derived from the following equation.

$$U = 331.45 + 0.607\ T\ (m/s)$$

wherein T indicates temperature.

The paragraph at page 4, line 36, beginning "From this equation, it is understood...", has been amended in the following manner:

From this equation, it is understood that a large dip that cannot be generated in room temperatures can sometimes be generated in high temperatures. On the contrary, a large dip that was small in high temperatures can also sometimes be generated in room temperatures. As the reason for generating spurious noise has not been solved, the conventional acceleration sensor has to be designed to have the desirable resonance frequency fo. In addition, the constructing of a conventional acceleration sensor [needs] is a complicated process, that is, the acceleration sensor has to be customized to have a [dimension] structure to avoid spurious noise, which needs repeated change of [dimension] the dimensions of the acceleration sensor components.

The paragraph at page 5, line 7, beginning "The acceleration sensor has the resonance frequency...", has been amended in the following manner:

The acceleration sensor has the resonance frequency fo in the usable frequency range or broad frequency range. The complicated process described above causes another problem, that is, it is extremely difficult to design the sensor casing of the acceleration sensor to have [common] standardized dimensions.

The paragraph at page 5, line 19, beginning "In accordance with a first aspect of the present invention...", has been amended in the following manner:

In accordance with a first aspect of the present invention, there is provided an acceleration sensor for detecting an acceleration caused by an object oscillated in an oscillation direction, comprising[:] a sensor casing, an oscillation plate and a piezoelectric element. The sensor casing [having] has a center axis and [to be] is positioned in coaxial alignment with the oscillation direction to receive the acceleration, the sensor casing [having] has a first and second circular inner surfaces opposing to and spaced apart along the center axis from each other at a first space distance, and a third cylindrical inner surface connected at one end with the first inner surface and at the other end with the second inner surface to define a cylindrical closed space[; an] . The oscillation plate is accommodated in the closed space of the sensor casing and [having] has a central portion securely supported by the sensor casing and a peripheral portion integrally formed with the central portion and extending radially outwardly of the central portion to be freely movable with respect to the sensor casing[, the] . The oscillation plate [having] has a peripheral end surface spaced apart from the third inner surface of the sensor casing at an annular gap small enough to enable the oscillation plate to oscillate with respect to the sensor casing[, the] . The oscillation plate [having] also has a first flat surface opposing to and spaced apart along the center axis from the first inner surface of the sensor casing at a second space distance, and a second flat surface opposing to and spaced apart along the center axis from the second inner surface of the sensor casing at a third space distance, with the oscillation plate being partly oscillatable along the center axis with respect to the sensor casing[; and a] . The piezoelectric element [having] has a first and second [surfaces] surface and is provided on at least one of the

first and second flat surfaces of the oscillation plate to generate a voltage indicative of the acceleration [when the acceleration is exerted on the sensor casing to have the oscillation plate partly oscillated along the center axis with respect to the sensor casing with the peripheral portion of the oscillation plate being deformed; in which the] . The first space distance is less than or equal to the diameter of the third inner surface of the sensor casing multiplied by 0.1.

The paragraph at page 6, line 6, beginning "In accordance with a second aspect of the present invention...", has been amended in the following manner:

In accordance with a second aspect of the present invention, there is provided an acceleration sensor for detecting an acceleration caused by an object oscillated in an oscillation direction, comprising[:] a sensor casing, an oscillation plate, a first piezoelectric element and a second piezoelectric element. The sensor casing and oscillation plate are the same as in the first aspect of the invention. [sensor casing having a center axis and to be positioned in coaxial alignment with the oscillation direction to receive the acceleration, the sensor casing having first and second circular inner surfaces opposing to and spaced apart along the center axis from each other at a first space distance, and a third cylindrical inner surface connected at one end with the first inner surface and at the other end with the second inner surface to define a cylindrical closed space; an oscillation plate accommodated in the closed space of the sensor casing and having a central portion securely supported by the sensor casing and a peripheral portion integrally formed with the central portion and extending radially outwardly of the central portion to be freely movable with respect to the sensor casing, the oscillation plate having a peripheral end surface spaced apart from the third inner surface of the sensor casing at

an annular gap small enough to enable the oscillation plate to oscillate with respect to the sensor casing, the oscillation plate having a first flat surface opposing to and spaced apart along the center axis from the first inner surface of the sensor casing at a second space distance, and a second flat surface opposing to and spaced apart along the center axis from the second inner surface of the sensor casing at a third space distance, the oscillation plate being partly oscillatable along the center axis with respect to the sensor casing; a] The first piezoelectric element [having] has first and second surfaces and is provided on the first flat surface of the oscillation plate to generate a voltage indicative of the acceleration [when the acceleration is exerted on the sensor casing to have the oscillation plate partly oscillated along the center axis with respect to the sensor casing with the peripheral portion of the oscillation plate being deformed; and a] , and the second piezoelectric element [having] has first and second surfaces and is provided on the second flat surface of the oscillation plate to generate a voltage indicative of the acceleration [when the acceleration is exerted on the sensor casing to have the oscillation plate partly oscillated along the center axis with respect to the sensor casing with the peripheral portion of the oscillation plate being deformed; in which the] . The first space distance is less than or equal to the diameter of the third inner surface of the sensor casing multiplied by 0.1.

The paragraph at page 6, line 34, beginning "In accordance with a third aspect of the present invention...", has been amended in the following manner:

In accordance with a third aspect of the present invention, there is provided an acceleration sensor for detecting an acceleration caused by an object oscillated in an oscillation direction, comprising[:] a sensor casing [having a center axis and to be

positioned in coaxial alignment with the oscillation direction to receive the acceleration, the] , an oscillation plate, and a piezoelectric element. The sensor casing [including] includes a cylindrical fixed case member having a circular bottom portion having a first circular inner surface, a cylindrical side portion integrally formed with the bottom portion, and a supporting portion projecting from the bottom portion, [and] a cover member being provided on the fixed case member and having a circular cover portion having a second circular inner surface, and a cylindrical side portion integrally formed with the cover portion[, the] . The side portion of the fixed case member [having] has a third cylindrical inner surface connected at one end with the first inner surface, and the side portion of the cover member [having] has a fourth cylindrical inner surface connected at one end with the second inner surface, with the second inner surface of the cover portion of the cover member opposing to and spaced apart along the center axis from the first inner surface of the bottom portion of the fixed case member at a first space distance[, the] . The first inner surface of the bottom portion of the fixed case member, [and] the third inner surface of the side portion of the fixed case member, [and] the second inner surface of the cover portion of the cover member, and the fourth inner surface of the side portion of the cover member collectively [defining] define a cylindrical closed space[; an] . The oscillation plate is accommodated in the closed space of the sensor casing and [having] has a central portion securely supported by the supporting portion of the fixed case member of the sensor casing, and a peripheral portion integrally formed with the central portion and extending radially outwardly of the central portion [to be freely movable with respect to the sensor casing, the oscillation plate having a peripheral end surface spaced apart from the third inner surface of the side portion of the fixed case member at an annular gap small enough to enable the oscillation

plate to oscillate with respect to the sensor casing, the] . The oscillation plate [having] has a first flat surface opposing to and spaced apart along the center axis from the first inner surface of the bottom portion of the fixed case member at a second space distance, and a second flat surface opposing to and spaced apart along the center axis from the second inner surface of the cover portion of the cover member at a third space distance[, the oscillation plate being partly oscillatable along the center axis with respect to the sensor casing; and a] . The piezoelectric element [having] has a first surface held in contact with the second flat surface of the oscillation plate, and a second surface opposing to and spaced apart along the center axis from the second inner surface of the cover portion of the cover member at a fourth space distance[, the] . The piezoelectric element [being] is provided on the second flat surface of the oscillation plate in axial alignment with the oscillation plate to generate a voltage indicative of the acceleration [when the acceleration is exerted on the sensor casing to have the oscillation plate partly oscillated along the center axis with respect to the sensor casing with the peripheral portion of the oscillation plate being deformed; in which the] . The first space distance is less than or equal to the diameter of the third inner surface of the side portion of the fixed case member multiplied by 0.1, and in which the first space distance is less than or equal to the diameter of the fourth inner surface of the side portion of the cover member multiplied by 0.1.

The paragraph at page 8, line 1, beginning "In accordance with a fourth aspect of the present invention...", has been amended in the following manner:

In accordance with a fourth aspect of the present invention, there is provided an acceleration sensor for detecting an acceleration caused by an object oscillated in an

oscillation direction, comprising[:] a sensor casing [having a center axis and to be positioned in coaxial alignment with the oscillation direction to receive the acceleration, the] , an oscillation plate and a piezoelectric element. The sensor casing [including a] includes a cylindrical fixed case member, a metal base member, and a cover member. The cylindrical fixed case member [having] has a circular bottom portion having a first circular inner surface, and a cylindrical side portion integrally formed with the bottom portion[, the side portion of the fixed case member] having a first section close to the bottom portion of the fixed case member, a second section remote from the bottom portion of the fixed case member and radially inwardly bent, and an annular ledge section formed between the first and second sections with an annular ledge[, a] . The metal base member [having] has a circular base portion and a supporting portion[,] with the base portion having a second circular inner surface and a circular outer surface, and the supporting portion projecting from the second inner surface[, the] . The base portion of the metal base member [having] has a central section integrally formed with the supporting portion, and a peripheral section extending radially outwardly of the central section[, the] . The metal base member is mounted on the annular ledge of the fixed case member with a resilient ring intervening between the second section of the side portion of the fixed case member and the peripheral section of the base portion of the metal base member to hermetically seal the gap between the second section of the side portion of the fixed case member and the peripheral section of the base portion of the metal base member[, the] . The first section of the side portion of the fixed case member [having] has a third cylindrical inner surface connected at one end with the first inner surface of the bottom portion of the fixed case member and at the other end with the second inner surface of the base portion of the metal base member, with the second inner surface of

the base portion of the metal base member opposing to and spaced apart along the center axis from the first inner surface of the bottom portion of the fixed case member at a first space distance[, and a] . The cover member [being] is provided on the outer surface of the metal base member and [having] has a peripheral section firmly engaged with the second section of the side portion of the fixed case member[, the] . The first inner surface of the bottom portion of the fixed case member, the second inner surface of the base portion of the metal base member, and the third inner surface of the first section of the side portion of the fixed case member collectively [defining] define a cylindrical closed space[; an] . The oscillation plate accommodated in the closed space of the sensor casing and having a central portion securely supported by the supporting portion of the metal base member of the sensor casing, and a peripheral portion integrally formed with the central portion and extending radially outwardly of the central portion [to be freely movable with respect to the sensor casing, the oscillation plate having a peripheral end surface spaced apart from the third inner surface of the first section of the side portion of the fixed case member at an annular gap small enough to enable the oscillation plate to oscillate with respect to the sensor casing, the] . The oscillation plate [having] has a first flat surface opposing to and spaced apart along the center axis from the first inner surface of the bottom portion of the fixed case member at a second space distance, and a second flat surface opposing to and spaced apart along the center axis from the second inner surface of the base portion of the metal base member at a third space distance[, the oscillation plate being partly oscillatable along the center axis with respect to the sensor casing; and a] . The piezoelectric element [having] has a first surface opposing to and spaced apart along the center axis from the first inner surface of the bottom portion of the fixed case member at a fourth space distance, and a second surface held in contact with

the first flat surface of the oscillation plate[, the] . The piezoelectric element being provided on the first flat surface of the oscillation plate in axial alignment with the oscillation plate to generate a voltage indicative of the acceleration [when the acceleration is exerted on the sensor casing to have the oscillation plate partly oscillated along the center axis with respect to the sensor casing with the peripheral portion of the oscillation plate being deformed; in which the] . The first space distance is less than or equal to the diameter of the third inner surface of the first section of the side portion of the fixed case member multiplied by 0.1.

The paragraph at page 14, line 19, beginning "Referring now to the drawings...", has been amended in the following manner:

Referring now to the drawings, particularly to FIG. 1, the first preferred embodiment of the acceleration sensor is assumed to be installed on an engine of an automotive vehicle. The acceleration sensor 30 comprises a sensor casing 31 having a center axis 32 and to be positioned on the engine, not shown, in coaxial alignment with or otherwise in parallel relationship with an oscillation direction to receive an acceleration. More specifically, the oscillation direction is coincident with or otherwise in parallel relationship with the center axis 32 of the engine, i.e., the direction of the stroke of the engine to ensure detection of the acceleration acted on the engine. The above engine constitutes an object oscillated in the oscillation direction [as defined in the claims]. The sensor casing 31 has first and second circular inner surfaces 33 and 34 opposing to and spaced apart along the center axis 32 of the sensor casing 31 from each other at a first space distance L1, and a third cylindrical inner surface 35 connected at one end with the first inner surface 33 and at the other end with the second inner surface 34 to define a cylindrical closed space V.

The paragraph at page 37, line 11, beginning "In the present embodiment of the acceleration...", has been amended in the following manner:

In the present embodiment of the acceleration sensor 500 thus constructed in the above, the distances Ll and L2 of the closed space sections Vl and V2 are set at respective values less than or equal to 0.1 times the diameter D of the inner surface of the fixed case member 501 and the cover member 504 to ensure that the standing wave is prevented from being generated in the closed space V of the acceleration sensor 500. The closed space sections V1 and V2 small in size can bring the frequency fh of the acoustic resonance out of the upper limit of the usable range of the frequency of the acceleration sensor 500. This means that the acceleration sensor according to the present invention makes it possible to prevent the detection accuracy of the acceleration sensor from deteriorating stemming from the spurious noise caused by the anti-resonance of the standing wave and the acoustic resonance generated in the closed space V, as well as to produce the acceleration sensor at a low cost with the fixed case member and the cover member commonly used and with the oscillation bodies different in diameter.

The paragraph at page 40, line 1, beginning "In the acceleration sensor according to the present invention...", has been amended in the following manner:

In the acceleration sensor according to the present invention, the distance L of the closed space V is less than or equal to the diameter of the inner surface of the fixed case member and the cover member multiplied by 0.1, and the space distances Ll and L2 are respectively less than or equal to the diameter of the inner surface of the fixed case member and the cover member multiplied by 0.1. The acceleration sensor thus constructed in the above makes it possible (1) to prevent the detection accuracy of the

acceleration sensor from deteriorating stemming from the spurious noise caused by the anti-resonance of the standing wave and the acoustic resonance being generated in the closed space V, and (2) to produce the acceleration sensor at a low cost with the fixed case member and the cover member commonly used.

The paragraph at page 42, line 31, beginning "The previously mentioned items (1), (2) and (3)...", has been amended in the following manner:

The previously mentioned items (1), (2) and (3) mean that the resonance frequency fo1 of the fixed case member 701 and the metal base member 704 is more than or equal to about three times the resonance frequency fo of the oscillation plate 702 and the piezoelectric element 703. Further, the previously mentioned items (1) and (3) are concerned with conditions required to prevent the characteristics from deteriorating stemming from the spurious noise caused by the anti-resonance of the acoustic resonance of Helmholtz and the acoustic standing wave being generated in the closed space V, i.e., it is required to set the closed space sections V1 and V2 relatively small in size for the purpose of bringing the frequency of the acoustic resonance out of the upper limit of the usable range of the frequency of the acceleration sensor, and it is required to set a relatively large acoustic resistance in the closed space V for the purpose of preventing the standing wave from being generated in the closed space V. Further, the previously mentioned item (4) is concerned with a condition required to reduce the influence of the oscillation of cover member 705 on the oscillation of the oscillation plate 702 and the piezoelectric element 703. This reduction of the influence is realized by having the cover member 705 composed of solid material to impart the increased resonance frequency to the cover member 705, and by having the cover member 705 composed of the material

that has low sharpness of resonance Q and low influence of temperatures change to reduce the amplification of the cover member 705. Here the sharpness of resonance Q means sensitivity of resonance.

IN THE ABSTRACT:

The abstract has been amended in the following manner:

An acceleration sensor for detecting an acceleration caused by an object oscillated in an oscillation direction, comprises a sensor casing having a center axis [and to be] that is positioned in coaxial alignment with the oscillation direction to receive the acceleration, [the] an oscillation plate and a piezoelectric element. The sensor casing [having] has first and second circular inner surfaces opposing to and spaced apart along the center axis from each other at a first space distance, and a third cylindrical inner surface connected at one end with the first inner surface and at the other end with the second inner surface to define a cylindrical closed space[, an] . The oscillation plate is accommodated in the closed space of the sensor casing and [having] has a central portion securely supported by the sensor casing and a peripheral portion integrally formed with the central portion and extending radially outwardly of the central portion[, and a] . The piezoelectric element is provided on the oscillation plate to generate a voltage indicative of the acceleration[, in which] . The first space distance is less than or equal to the diameter of the third inner surface of the sensor casing multiplied by 0.1.